DOI: https://doi.org/10.58423/2786-6742/2022-1-275-283
UDC 658.14/.17(047.32)

Gergő THALMEINER
PhD. student Hungarian University of Agriculture and Life Sciences,
Gödöllő, Hungary

Sándor GÁSPÁR
PhD. student Hungarian University of Agriculture and Life Sciences,
Gödöllő, Hungary

Zoltán ZÉMAN
Full Professor Hungarian University of Agriculture and Life Sciences,
Gödöllő, Hungary

MODELING OF THE REPORTING ACTIVITIES OF A CRANE MANUFACTURING ORGANIZATION

Анотація. *Промислова виробнича діяльність за останні роки суттєво змінилася. На додаток до стандартизованих процесів масового виробництва все більше посилюється індивідуальна виробнича діяльність, орієнтована на клієнта. У виробництві на замовлення з орієнтацією на клієнта клієнт є не тільки пасивним спостерігачем, але й активним учасником процесів проектування та виробництва. Через їхню унікальну природу оцінка ефективності організацій може викликати ряд проблем. У результаті розвитку цифровізації та економічних IT-інновацій з'явилася розгалужена система інструментів, а для аналізу вимірюваних даних можна використовувати ряд методів. Серед методологій аналізу слід виділити управління ключовими показниками ефективності (KPI), що є основою систем контролінгу. У результаті змін оцінка та вираження ефективності організації більше не повинні зосереджуватися на аналізі поточних умов, а на прогнозуванні очікуваних майбутніх результатів. Для цього в якості базової вимоги сформульовано використання ефективної інфраструктури та професійних і статистико-математичних методів. Інтерпретація інформаційного змісту прогнозних KPI і, таким чином, підтримка управлінських рішень має залежати від різних оцінок і норм стандартизації. Це забезпечує більш точну та реалістичну оцінку діяльності організації. Сьогодні оцінку ефективності організації можна розглядати як основне контрольне завдання, метою якого є широке дослідження та оцінка діяльності організації. Управління обмежено раціонально приймає рішення, а це означає, що воно може приймати рішення лише на основі наявної інформації. Мета контролюючої діяльності полягає в тому, щоб забезпечити керівництво звітністю, яка підходить для оцінки процесів і прийняття орієнтованих на майбутнє рішень шляхом розкриття обширної інформації та широкого методологічного аналізу. Тому особливо підкреслюється, що управління більше не повинно бути реактивним, а проактивним, чого можна досягти шляхом прогнозного аналізу та прийняття рішень на основі інформації, отриманої з прогнозних оцінок.*
Ключові слова*: оцінка ефективності, контролінг, звітність, управління KPI, моделювання.*

JEL Classification: L60, M41.

Absztrakt. *Az ipari feldolgozóipari tevékenység jelentősen megváltozott az elmúlt években. A szabványosított - tömeggyártási folyamatok mellett egyre inkább felerősödtek a vevőorientált egyedi termelési tevékenységek. Az ügyfélközpontú egyedi gyártás során a vevő nem csak passzív megfigyelője, hanem aktív résztvevője is a tervezési és gyártási folyamatoknak. Egyedi jellegükből adódóan a szervezetek teljesítményének értékelése számos kihívást jelenthet. A digitalizáció és a gazdasági informatikai innovációk fejlődésének köszönhetően kiterjedt eszközrendszer áll rendelkezésre és számos módszer alkalmazható a mért adatok elemzésére. Az elemzési módszertanok közül kiemelendő a kontrolling rendszerek alapját képező Key Performance Indicator (KPI)*

menedzsment. A változások miatt a szervezeti teljesítmény értékelése és kifejezése már nem a jelenlegi állapotok elemzésére, hanem a várható jövőbeni teljesítmény előrejelzésére irányul. Ennek elérése érdekében alapvető követelményként fogalmazódik meg a hatékony infrastruktúra, valamint a szakmai és statisztikai-matematikai módszerek alkalmazása. A prediktív KPI információtartalmának értelmezése és így a vezetői döntéstámogatás a különböző értékelésektől és szabványosítási normáktól függ. Napjainkban a szervezeti teljesítményértékelés alapvető kontrolling feladatnak tekinthető, melynek során a szervezeti teljesítmény széleskörű feltárása, értékelése a cél. A vezetés korlátozottan racionális a döntések meghozatalakor, ami azt jelenti, hogy csak a rendelkezésre álló információk alapján tud dönteni. A controlling célja, hogy a menedzsment számára olyan beszámolási tevékenységet biztosítson, amely alkalmas a folyamatok értékelésére és a jövőbe mutató döntések meghozatalára a kiterjedt információk feltárásával és az adatok kiterjedt módszertani elemzésével. Ezért kiemelten hangsúlyozzák, hogy a menedzsmentnek már nem reaktívnak, hanem proaktívnak kell lennie, ami a prediktív elemzések kiértékelésével és a prediktív értékelésekből származó információk alapján történő döntéshozatallal érhető el.
Kulcsszavak: *teljesítményértékelés, kontrolling, jelentéskészítés, KPI menedzsment, modellezés.*

Abstract. *Industrial manufacturing activity has changed significantly in recent years. In addition to standardized - mass production processes, customer - oriented individual production activities have become increasingly strong. In custom manufacturing with a customer focus, the customer is not only a passive observer but also an active participant in the design and manufacturing processes. Due to their unique nature, evaluating the performance of organizations can present a number of challenges. As a result of the development of digitalisation and economic IT innovations, an extensive system of tools is available, and a number of methods can be used to analyze the measured data. Among the analysis methodologies, the Key Performance Indicator (KPI) management, which is the basis of controlling systems, should be highlighted. As a result of the changes, the evaluation and expression of organizational performance should no longer focus on analyzing current conditions, but on forecasting expected future performance. In order to achieve this, the use of efficient infrastructure and professional and statistical-mathematical methods is formulated as a basic requirement. The interpretation of the information content of predictive KPIs and thus management decision support should depend on different assessments and standardization norms. Nowadays, organizational performance evaluation can be regarded as a basic controlling task, during which the goal is the extensive exploration and evaluation of organizational performance. Management is limitedly rational when making decisions, which means that it can only make decisions based on available information. The purpose of the controlling is to provide the management with a reporting activity that is suitable for evaluating the processes and making future-oriented decisions by uncovering extensive information and extensive methodological analysis of the data. It is therefore particularly emphasized that management should no longer be reactive, but proactive, which can be achieved by evaluating predictive analyzes and making decisions based on the information derived from the predictive evaluations.*
Keywords*: performance evaluation, controlling, reporting, KPI management, modeling.*

Introduction. Extensive integration of paradigms such as Industry 4.0, big-data, robotics, and cloud-based computing in today's manufacturing sector is leading new operating approaches for factories and increasing competition [18, p. 2948]. The change in operational approaches is influenced not only by the development of digitization, but also by individual production, which is becoming increasingly important during production. The special nature of custom manufacturing is the unique customer needs that form the basis of the custom manufacturing strategy of custom manufacturing. By recognizing the value and benefits of delivering products that meet the unique needs of their customers, customizing products becomes a critical business differentiator [19, p. 1034]. Unlike traditional manufacturing, customers in a modern

manufacturing environment are not passive observers of the production of their products, but can actively participate in the design and manufacturing phases of product composition. Due to its unique nature, industrial crane manufacturing is a special industry. In most cases, the individual needs of the customers come to the fore during production. As a result, customer needs can be considered as a bottleneck in the design and manufacturing processes. The industry is an excellent example of the trend for products that cannot be produced using mass-produced technologies to be produced in developed countries instead of low-income developing ones. The use of Key Performance Indicators (KPIs) can be used appropriately to track manufacturing activity. KPIs provide an opportunity to evaluate performance and provide information related to manufacturing processes.

Literature Review. In most cases, organizational performance evaluation refers to the result and structure of the execution of the tasks and processes necessary to achieve the organization's strategic goals, characterized by quantitative and qualitative indicators. Increasing the level of organizational performance and achieving goals results from the optimal and coordinated use of production factors and the aggregation of individual performances [7, p. 117-118]. The primary and most important purpose of the performance evaluation is to break down organizational goals to the level of different units and individuals and to create the possibility that their implementation can be monitored. The performance evaluation only becomes effective if the organization's unit-by-unit processes and member-by-member activities support the achievement of the organization's strategic goals. Performance evaluation plays a particularly decisive role among the functions that create complex systems [4, p. 97]. Performance evaluation systems serve as the basis for performance evaluation. At the heart of these systems is the evaluation of the realization of the strategic objectives defined in advance by the given organization [20, p. 102]. The system evaluates the strategic goals by defining, measuring, and monitoring the related results and performance indicators, using established standards, measurement methods, and evaluation mechanisms. An effective performance evaluation system must meet the following characteristics:

1. Analyzes can be performed with as few indicators as possible.
2. Each measured item must be linked to the success factors.
3. Indicators should cover the time dimensions of past, present and future.
4. When defining the indicators, the interests of customers, shareholders and other interested parties must be fulfilled.
5. The performance evaluation should cover from the highest level to the lowest level.
6. Aggregation of several indicators is necessary for a more extensive and accurate assessment of performance.
7. The indicators must match the dynamic changes of the environment and the organization.
8. Indicators must provide accurate feedback on the fulfillment of organizational goals [5, p. 12-17].

During the evaluation of the indicators, in most cases, the plan-fact analysis method is used. The plan value defined in accordance with the goals is the basis of comparison by which the performance evaluation can be created. During the evaluation, if the predetermined indicators reach or will reach the plan values, then the

organization is expected to fulfill its strategic goals, but if the indicators do not reach or are not expected to reach the various plan values, then the strategic objectives are not expected to be achieved. Consequently, the determination of the indicators included in the evaluation is an important factor. The most important requirement for indicators is to provide feedback on processes as accurately and clearly as possible [7, p. 120]. Before including the indicators in the analysis, it is necessary to evaluate them, on the basis of which their applicability is determined [16, p. 493]. For decision-makers, assessing this is a complex task, during which the relevance of the indicator to the target variable, the information content that can be produced, and the feasibility of its practical measurability must be evaluated [17, p. 17-18].

KPI management

One of the most important tools for making well-founded analyzes is the so-called KPI (Key Performance Indicators) management. By KPIs we mean the definition of indicators that specialize in tracking processes and providing information about them to management [15, p. 77]. KPIs are a set of indicators that focus on those aspects of organizational performance that are most critical to an organization's current and future success [10, p. 17]. These complex indicators are nowadays used, among other things, to monitor different functional areas, to formulate strategies, to set objectives for the next period, and to characterize areas that require more serious resources [8, p. 31]. By defining and quantifying KPIs, the critical goals that an organization wants to achieve are defined. Therefore, KPIs are suitable for strategic measurement, which can be derived directly from e.g. based on physical measurements, data, and other KPIs [12, p. 227]. In addition to the critical success factors of the organization and the related performance indicators, the formulation and measurability of goals can provide several benefits: they support organizational communication, identify factors that increase performance, and contribute to more efficient operations [14, p. 204]. Because many KPIs can be defined within manufacturing, it is possible to structure them according to different approaches [9, p. 12]. The structures created in this way can be called performance measurement systems. Among the different groupings, the hierarchical KPI structure developed by Brundage et al. (2017) should be highlighted [6, p. 455]. During this grouping, three different levels were defined, low-level metrics, mid-level metrics, and KPIs. Low-level metrics are measurable values. Mid-level indicators are calculated through low-level metrics. KPIs can be calculated from mid-level metrics. Another grouping in a similarly hierarchical structure is described by Kang et al. (2017). KPIs can be divided into three hierarchies: comprehensive KPIs, core KPIs, and supporting elements. Supporting elements are data collected directly during manufacturing that can be used to calculate basic KPIs [11, p. 6333–635]. The values of comprehensive KPIs can be determined by correlation analysis and consideration of core KPIs. Comprehensive KPIs provide feedback on the overall performance of the manufacturing system [13, p. 547]. The indicators defined by the organization, their organization and aggregation can be considered as a bottleneck in management decision-making [21, p. 4], [3, p. 8]. Defining relevant, simple, and achievable KPIs for cost-benefit analysis is the key to effective performance management. KPI management not only involves the identification, selection, and analysis of significant performance indicators during operational processes, but also provides information for evaluation [1, p.144-145].

Purpose Of The Sudy. The purpose of this study is to explore the operation of an industrial crane manufacturing organization, with a specific emphasis on controlling activities and performance evaluation. During the presentation of the controlling system, the KPIs used during performance evaluation are described, and the method for categorizing predictive KPIs is presented. The purpose of the study is to demonstrate the importance of controlling's reporting activity in the evaluation process, and the transformation of data with information for management decision-making.

Material And Methodology. In our research, we performed an instrumental case study. The subject of the case study was an industrial crane manufacturing organization operating in the Central Hungary region. The organization currently employs 120 people, which includes the organization's management. We chose the instrumental case analysis method to explore the advantages and disadvantages of existing theories and methods used in practice. In instrumental case analysis, it is not the understanding of a particular case that is important, but, for example, the interpretation or conceptualization of a phenomenon [2, p. 58]. The subjects of the semi-structured in-depth interviews were the staff of the organization, finance and controlling. The semi-structured in-depth interview methodology was used in order to explore the areas that the interviewees would like to highlight on in relation to the research area. Our goal is to map the KPIs used in corporate performance evaluation and to analyze their evaluation process.

Research Results And Discussions. The organization involved in the case study focuses primarily on manufacturing, with the primary goal of increasing process efficiency. Thus, increasing the efficiency and productivity of the organization has been formulated as a strategic goal. The primary task of controlling activity is to monitor performance, which is performed using the organization's KPI system. It analyzes the indicators in a predictive way, which provides an opportunity to explore the intervention points in time and thus increase the efficiency of the processes. The operation of the controlling system is under the management of the organization. In business planning and plan-fact analysis, the organization uses a top-down planning method. It follows that the task of economic management is very hard, as they need to know the expected performance of the various operational processes. An inadequate target can greatly skew the final performance evaluation. The primary task of the organization's controlling system is to evaluate the organization's performance. Performance evaluation is based on predefined KPIs that are organized into a predefined logical structure. Three different levels are defined in the hierarchical structure. The grouping of levels can be observed in the literature, Kang et al. (2016): the level of supporting elements, core KPIs, and comprehensive KPIs. The primary purpose of using a hierarchical structure is to provide a useful tool for managing manufacturing operations, exploring intervention points, and implementing continuous improvement [11, p. 6341–6342]. When structuring KPIs, emphasis is placed on quality, productivity, maintenance, and time and quantity.

The hierarchical structure of performance evaluation and the KPIs used in the organizational controlling system are illustrated in Figure 1.

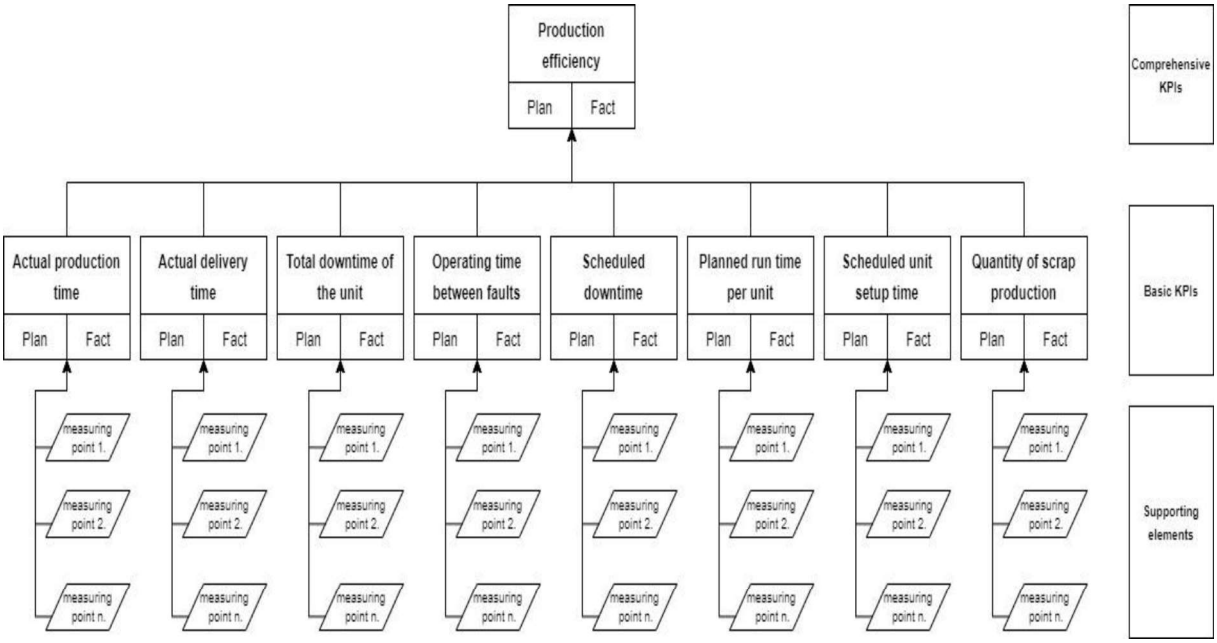

Figure 1. Controlling system

Source: Own research, own editing

The results of the predefined KPIs are the basis for evaluating the reporting activity. Each indicator has a plan-fact analysis that can be used to identify intervention points. Each KPI is measured periodically, from the actual results of the actual data of which a forecast is made for the given period. The forecast is based on the plan-fact analysis ratio for the indicators. During the reporting activity, the reasons for the discrepancies and the intervention options for the discrepancies are summarized based on the KPI tables. The compilation of the summary report for the period is the responsibility of the manager, but the evaluation and the formulation of possible intervention action plans are the responsibility of the economic management. The report compiled in this way is evaluated by the Board of Directors and the economic management, during which the intervention steps that can lead to the improvement of performance are voted on.

In the controlling system of the enterprise, the data analysis method linked to the indicators extrapolates the aggregated data of the given period and compares this value with the given target values. The data analysis is performed for each indicator, thus an extrapolated value is determined based on the actual data of the indicator. This extrapolated value is compared with predefined target values for KPIs. Thus, during the plan-fact analysis, the actual value will be the extrapolated value of the indicator and this will be compared with the plan value. Thus, the plan-fact analysis ratio provides feedback on the expected value of the given indicator, based on which the need for intervention can be formulated in advance. The linear extrapolation method of the enterprise is structured as follows:

$$E = F/N*T_n \quad (1)$$

where, E = Extrapolated value, F = current result of the examined period, N = number of elapsed days of the examined period, T_n = planned time interval of the examined period

$$Q = E/P \quad (2)$$

where, Q = Plan-Fact analysis ratio value, E = Extrapolated value, P = Predefined plan value

$$T = (Q-1)* 100 \quad (3)$$

where, T = Extrapolated plan-fact analysis ratio in%, Q = Plan-fact analysis ratio value

The organization has a predefined set of rules for evaluating differences in plan-fact analysis. The set of rules applies at all levels of the performance evaluation hierarchical structure. Consequently, this set of rules is also used to measure indicators for metrics, core KPIs and the overall KPI. The aggregation of the indicators is averaged. Based on the system of rules, the indicators evaluate the differences determined on the basis of plan-fact analysis according to different categories. During the evaluation, it should be emphasized that a negative deviation of revenues compared to the pre-defined target values means non-fulfillment of the target value of the indicator, while a positive deviation from the target values of costs means non-fulfillment of the target value of the indicator.

The organization classifies the indicators into four categories during the evaluation. The limits of the categories are determined on the basis of information collected in previous years. It uses different colors to denote categories, which have the following meanings:

- Blue: The value of the indicator will meet the target value associated with the end of the period under review, so no intervention is required. The extrapolated actual value and the predefined design value are equal to or do not exceed the 5% negative deviation. In this case, the deviation of the indicator design-fact analysis is $0\% \leq x \leq 5\%$.
- Gray: The value of the indicator is not expected to meet the target for the period under review. Non-compliance in this case shall not exceed a deviation of 8% from the design value associated with the indicator. Continuous monitoring of the value of the indicator is particularly significant, as this category is still an acceptable non-compliance, so no further intervention is needed in this case. In this case, the value of the difference between the extrapolated actual value of the indicator and the predefined design value is $5\% < x \leq 8\%$.
- Orange: The value of the indicator is significantly lower than the target value of the examined period, it expresses a maximum deviation of 15%. If the value of the indicator falls into this category, significant intervention is required. In this case, the difference between the extrapolated actual value of the indicator and the predefined design value is between $8\% < x \leq 15\%$.
- Red: The value of the indicator will not meet the target value associated with the period under review, so significant intervention is warranted, which means not only overestimating the processes of implementing the activities, but also overestimating and, if necessary, modifying the planning. In this case, the difference between the extrapolated actual value of the indicator and the predefined design value exceeds 15%, i.e. $15\% < x$.

Conclusions. The organization included in the research is a organization engaged in the manufacture of industrial cranes. The controlling system of the organization is a system based on plan-fact analysis. The controlling system focuses specifically on monitoring ongoing activities. In the controlling system, metrics and KPIs are defined at three hierarchical levels, which form the basis of the performance appraisal system. The primary task of the controlling activity is the performance evaluation of the organization, which is performed using predefined evaluation limits and a calculation method. The controlling system of the organization is predictive, therefore the values of the expected performance can be compared to the predefined target values. With the application of the predictive controlling system, it is possible to determine the intervention points, by which the strategic objective becomes achievable. A shortcoming of the controlling system is that it uses only one standardized norms for performance evaluation. This norm is a comparison to the plan values predefined by the organization. It would be necessary to include various standardized norms for a more comprehensive and realistic assessment of performance. By involving external benchmarks in the analysis, performance evaluation can provide more sound and appropriate feedback on the organization's competitiveness.

Supported by the ÚNKP-21-3. New National Excellence Program of the Ministry for Innovation and Technology from the Source of the National Research, Development and Innovation Fund.

References

1. Asih, I. - Purba, H. H. - Sitorus, T. M. (2020) Key Performance Indicators: A Systematic Literature Review. *Journal of Strategy & Performance Management*, Vol. 8, No. 4, pp. 142-155.
2. Babbie, E. (2012) The Practice of Social Research, 13th Edition, New York: Wadsworth Publishing. pp. 52-61. ISBN 978-1133049791
3. Barta, Á. - Molnár, M. (2021) Forecasting oil price based on online occurrence. *Modern Science*, Vol. 1, pp. 5-11.
4. Boda, B. (2015) A teljesítményértékelés szervezeti és egyéni dimenziói a köz- és a versenyszférában. *Hadtudomány*, 25 évf. pp. 91-101.
5. Brown, M. G. (1996) Keeping Score: Using the Right Metrics to Drive World-class Performance. New York: *Quality Resources*. 12-17. p. ISBN 978-0814403273
6. Brundage, M. P. - Bernstein, W. Z. - Morris, K. C. - Horst, J. A. (2017) Using Graphbased Visualizations to Explore Key Performance Indicator Relationships for Manufacturing Production Systems. Procedia CIRP, Vol. 61, pp. 451– 456.
7. Chege, S. M. - Wang, D. (2020) The impact of entrepreneurs' environmental analysis strategy on organizational performance. *Journal of Rural Studies*, Vol. 77, pp. 113-125.
8. Domínguez, E. - Pére, B. - Rubio, Á. L. - Zapata, M. A. (2019) A taxonomy for key performance indicators management. *Computer Standards & Interfaces*, Vol. 64 pp. 24-40.
9. Duru, O. - Bulut, E. - Huang, S. - Yoshida, S. (2013) Shipping Performance Assessment and the Role of Key Performance Indicators (KPIs): 'Quality Function Deployment' for Transforming Shipowner's Expectation. SSRN *Electronic Journal*, pp. 1-18.
10.Fanning, K. (2016) Big Data and KPIs: A Valuable Connection. *Corporate Accounting and Finance*, Vol. 27, No. 3, pp 17-19.
11.Kang, N. – Zhao, C. – Li, J. – Horst, J. A. (2016) A Hierarchical structure of key performance indicators for operation management and continuous improvement in production systems. *International Journal of Production Research*, 5421, pp. 6333–6350.
12.Liebrecht, C. – Jacob, A. – Kuhnle, A. – Lanza, G. (2017) Multi-criteria Evaluation of Manufacturing Systems 4.0 under Uncertainty. *Procedia CIRP*, Vol. 63, pp. 224–229.
13.Malaga, A. - Vinodh, S. (2021) "Evaluation of smart manufacturing performance using a grey theory-based approach: a case study", (2021) Evaluation of smart manufacturing performance using a

grey theory-based approach: a case study, Grey Systems: Theory and Application, Vol. 12 No. 3, pp. 522-550.
14.Parmenter, D. (2007) Key performance indicators (KPI): Developing, implementing, and using winning KPIs. Hoboken: J. Wiley. *pp. 384. ISBN13 (EAN): 9781119620778*
15.Peral, J. - Maté, A. - Marco, M. (2016) Application of data mining techniques to identify relevant key performance indicators. Computer Standards & Interfaces, Vol. 54, Issue 2, pp. 76-85.
16.Schnellbach, P. - Reinhart, G. (2015) Evaluating the effects of energy productivity measures on lean production key performance indicators. Procedia CIRP, Vol. 25, pp. 492-497.
17.Simons, R. (2000) Performance Measurement and Control Systems for Implementing Strategy. New Jersey: Prentice Hall. 17-18. p. ISBN 978-0132340069
18.Xu, L. D. - Xu, E. L. - Li, L. (2018) Industry 4.0: State of the art and future trends. International *Journal of Production Research*, Vol. 56, Issue 8, pp. 2941–2962.
19.Yu, S. - Lee, J. (2019) The effects of consumers' perceived values on intention to purchase upcycled products. Sustainability, Vol. 11, pp. 1034.
20.Zéman, Z. - Béhm, I. (2019) Módszertan vállalkozások pénzügyi teljesítményének mérésére. Budapest: Akadémiai Kiadó Zrt. pp. 260 ISBN: 9789634543558
21.Zéman, Z. - Mallinguh, E. B. (2020) An evaluation of the Fintech companies and the financial sector in Hungary. Economics & Working Capital, Vol. 1, No. 2, pp. 2-9.